Southern Thailand bryophytes I, with description of *Cololejeunea ramromensis*

Sahut Chantanaorrapint [1], **Tamás Pócs** [2]

1 – Department of Biology, Faculty of Science, Prince of Songkla University, 90112, Hat Yai, Songkhla, Thailand; chantanaorrapint@gmail.com
2 – *Corresponding author:* Institute of Biology, Department of Botany, Eszterházy Károly College, Pf. 43, H-3301, Eger, Hungary; colura@upcmail.hu

Abstract: T. Pócs, in cooperation with the Prince of Songkla University, together with S. Chantanaorrapint, K. U-Taynapuh, G.E. Lee, D. Tang and with S. Somadee, collected bryophytes in the southern part of Thailand, mainly in Nakhon Si Thammarat Province. The collection resulted in 540 bryophytes, mostly liverwort specimens belonging to about 170 species of which 150 taxa are already identified, mostly by the two authors. Among them 22 proved to be the first record to Thailand or to the whole Indochina and one, *Cololejeunea ramromensis* Pócs, new to science. A revision of *Lejeunea* species is in press, while identifications of *Drepanolejeunea* and some critical *Colura* and *Microlejeunea* species are to be published later. Analysing the distribution of the species, interesting biogeographic conclusions can be drawn. The dominance of Malesian species is obvious in contrast to northern Thailand, where the Himalayan-Chinese and southeast Asian elements form the majority.

Key words: *Cololejeunea,* epiphylls, Indomalesia, Khao Ramrome, Nakhon Si Thammarat.

Introduction

During the period between 24 October and 12 November the second author collected bryophytes guided or accompanied by S. Chantanaorrapint, K. U-Taynapuh, S. Somadee, botanists from Thailand, by G.E. Lee with her husband, D. Tang from Malaysia and by L. Papp, Hungarian entomologist. The aim of the collecting trip was to explore the less known bryoflora of southern Thailand, as the majority of previous collections originate from the northern half of the country. The exploration was carried out in cooperation with the Department of Biology, Faculty of Science, Prince of Songkla University, Hat Yai, Songkhla, Thailand. The first set of collected material is deposited in the herbarium of this University (PSU) and its duplicates are in the herbarium of the Botany Department, Institute of Biology, Eszterházy College, Eger, Hungary (EGR). Although during the trip we were able to visit only one locality (Khao Ramrome summit) at higher altitude (up to 945 m), the rich lowland and submontane rainforests also yielded many novelties. We tried to investigate also the oil bodies of liverworts during the field trip. In the following we give an account on the records new to science or to Thailand (according to Lai et al. 2008), identified by the two authors. The Calymperaceae materials were identified by S. Orbán and species of *Lopholejeunea* by A. Sass-Gyarmati (EGR). The *Lejeunea* species are revised and under publication by G.E. Lee et al. (2014) while the *Drepanolejeunea* material is studied by J. Inuthai (PSU).

Description of a new species

***Cololejeunea ramromensis* Pócs sp. nov.** (Figs 1-10)

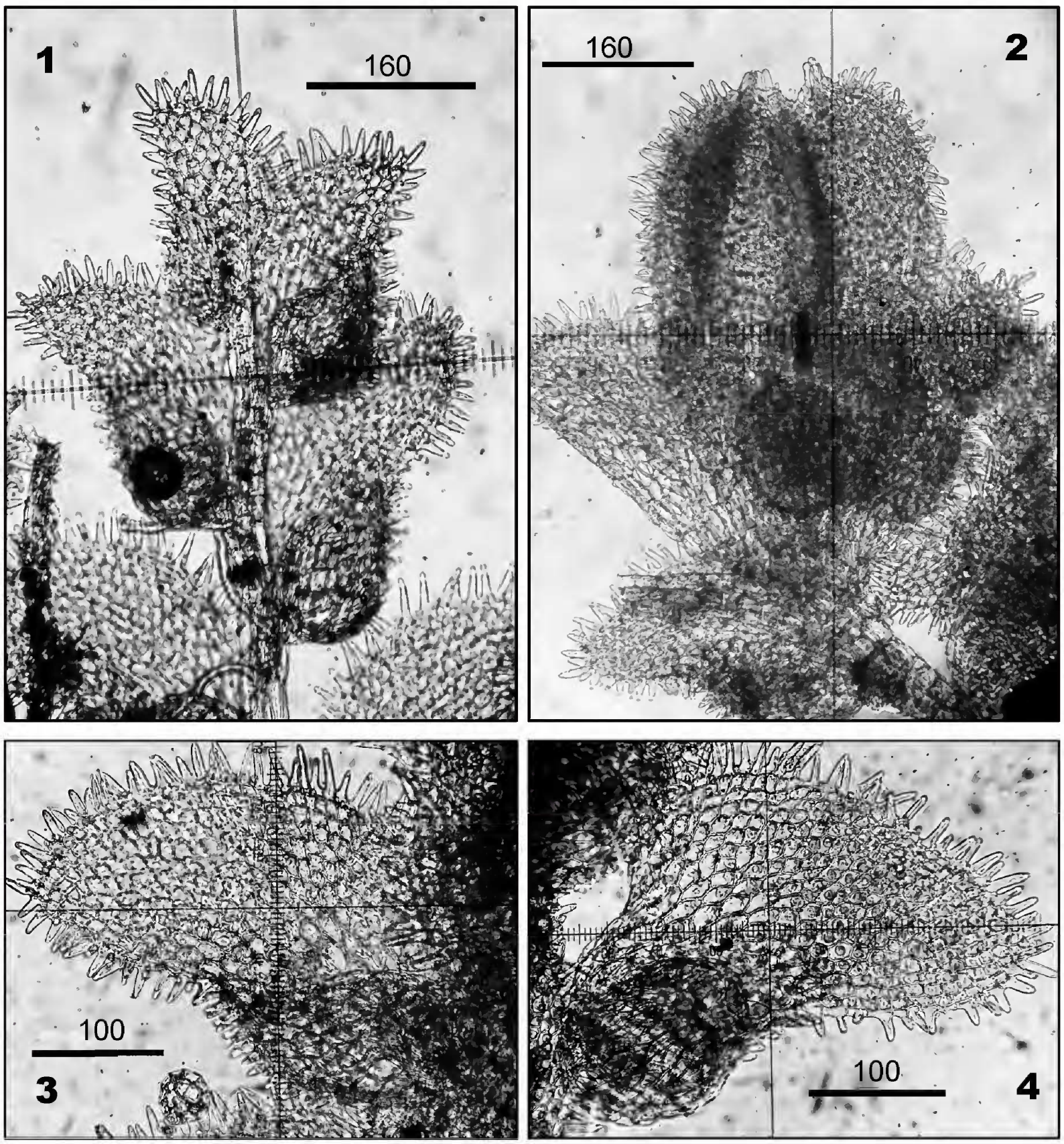
Subgenus ***Cololejeunea***

Type material: holotype PSU, isotype EGR, *T. Pócs* and *G.E.Lee 1213/T*, Thailand: Nakhon Si Thammarat Prov.: Summit of Mt. Khao Ramrome 8 km NW of Ron Phibun town, on the N side of the sharp ridge around Khao Ramrome Resort at 930-940 m alt. 08°14.18'N, 99°48.182'E. Date: 29. Oct. 2012. Montane rainforest.

Derivatio nominis: The new species is named after its type locality, the summit of Ramrome Mountains, a very rich bryophyte habitat.

Description: Minuscule, sparsely, irregularly branching, pale witish green, 1-4 mm long plants with shoot width of 450–500 µm, creeping on living filmy fern (Hymenophyllaceae) leaves in montane

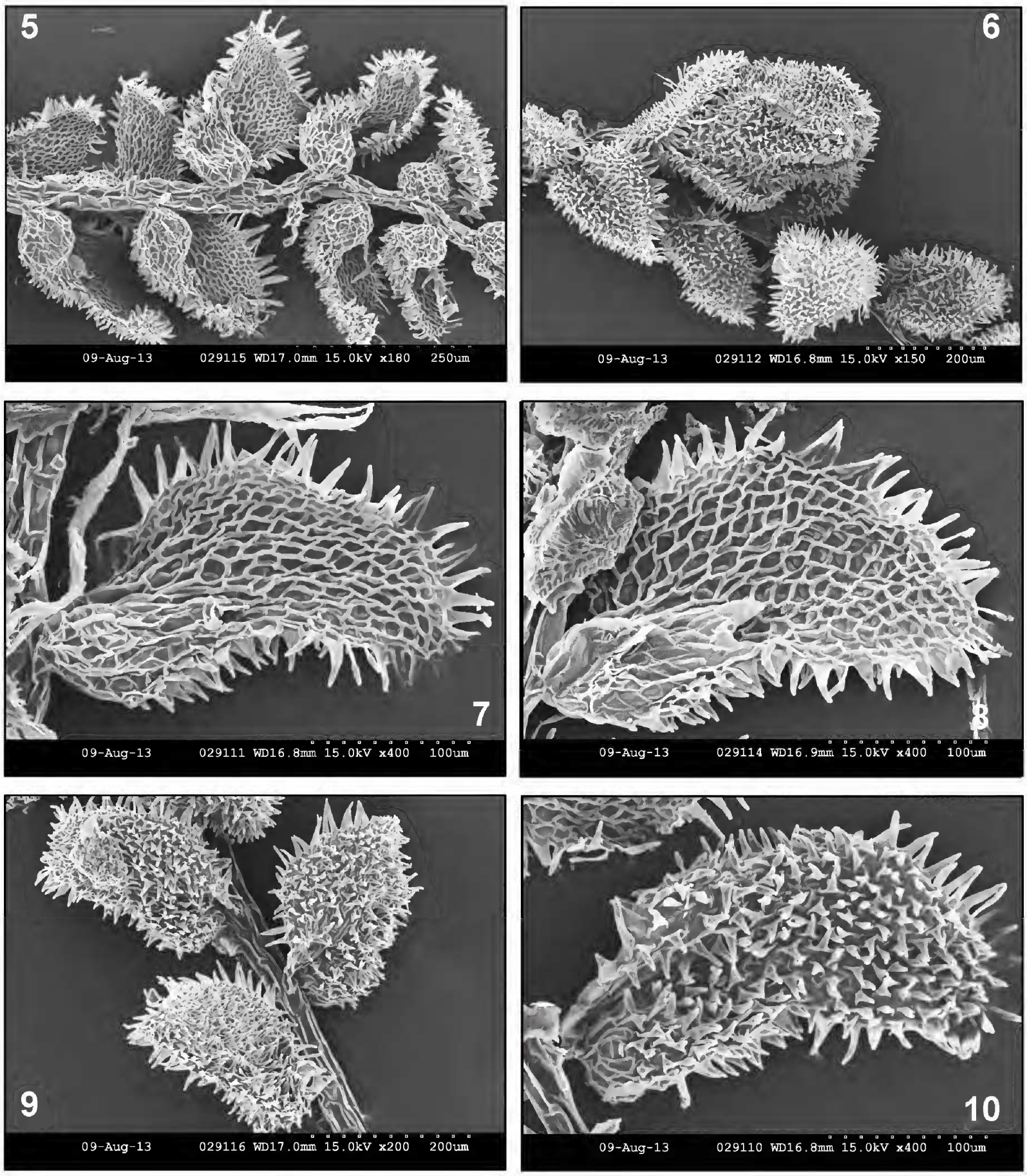
rain forest. Stem 25–40 µm thick, with one medullary and 5 cortical cell rows of which one forms the ventral merophyte. Branching thecal, *Lejeunea* type. Leaves distant, falcato-ovate, asymmetric, often with cuneate base. Size 300–350 x 120–195 µm, 18–23 cells wide. Lobe cells with thin walls and without trigones and any other thickenings. Marginal cells with ciliae 24–35 µm long. Submarginal cells subquadrate to rectangular, 10–12 x 7–9 µm, median lobe cells and lobule cells elongate rhomboid, 12–15 x 8–12 µm, basal ones more elongate, up to 36 µm long. Ventral side of lobe and lobule smooth, while on the dorsal side the cells bear 15–20 µm long ciliae, giving the leaves a "hirsute" surface. Lobule ovate, about 40% of the lobe length and width, with falcate or straight, one celled 1st and with a somewhat larger, 15-10 µm long 2nd tooth, which cross each other or lying parallel side by side. Hyaline papilla not seen. Stylus bicellular. Gemmae uncommon, round, consisting of 16 cells. Probably dioicous, as only female plants were observed. Gynoecium on shoot apex with one inno-



Figures 1-4. *Cololejeunea ramromensis* Pócs, sp. nov. 1 – Shoot, ventral view; 2 – Gynoecium; 3 – Leaf, ventral view; 4 – Leaf, dorsal view. All photographed from the holotype [scale bars in µm].

vation, female bracts about half perianth length and with lobule almost equalling the lobe. Perianth obovate, 320–480 x 200–220 µm, with a one cell row high, 15–20 µm long beak and with two larger dorsal and with one obtuse ventral carenae. The whole outer surface of bracts and of the perianth, similarly to the dorsal side of leaves, ciliately hirsute. Sporophyte rare, young capsule subglobose, of 105 µm diameter.

Differential diagnose: The new species is obviously related to *Cololejeunea kalombangerae* Pócs, known from Papua New Guinea and Solomon Islands (Pócs 2011) and to *Cololejeunea konratii* Pócs, from the Fiji Islands (Pócs 2012). The lobuli of the three species are similar to each other. But *C. ramromensis* is well distinguishable from the two other species by its much longer marginal and dorsal ciliae. In addition, its lobes are 18–23 cells



Figures 5-10. *Cololejeunea ramromensis* Pócs, sp. nov. 5 – Shoot, ventral view; 6 – Gynoecium; 7–8 – leaves, ventral view; 9 – Shoot, dorsal view; 10 – Leaf, dorsal view. SEM micrographs from the isotype [scale bars in µm].

wide while in the other two species only 12–14 cells wide. Instead of the long ciliae of the new species their dorsal lobe side has only relatively short papillae.
Distribution: At present it is known only from the type locality in southern Thailand.

Enumeration of taxa new to Thailand or Indochina

Remark: Citations of plant name authors follow Brummitt & Powell (1996).

***Cheilolejeunea lindenbergii* (Gottsche) Mizutani, 1979**
= *Cheilolejeunea luerssenii* (Stephani) Mizutani 1967
Localities: Nakhon Si Thammarat Prov.: Summit of Mt. Khao Ramrome 8 km NW of Ron Phibun town, on a sharp ridge behind the telecommunication tower, at 930-945 m alt. 08°14.28'N, 99°48.32"E. Mossy montane rainforest, on bark. Coll.: *T. Pócs, S. Chantanaorrapint & G.E. Lee 1209/D*. A species characterized by its very broad, emarginate or shallowly incised underleaves and by the high dorsal mammillae of the leaves.
Known distribution: Sri Lanka, Bangladesh, Indonesia and Malaysia (Kitagawa 1969), Fiji Islands (Pócs et al. 2011).

***Cheilolejeunea ryukyuensis* Mizutani, 1982**
Localities: Songkhla Prov.: Tone Nga Channg waterfall area 25 km WSW of Hat Yai town, at 120-180 m alt. 06°56.85'N, 100°14.06'E. Rocky hill rainforest, on bark. Coll.: *T. Pócs & G.E. Lee 1207/A*; Nakhon Si Thammarat Prov., Sichon Distr.: Nam Tok Sikiet Nat. Park, Si Keed Waterfalls area at 100 m alt. 09°00'N, 99°46.32'E. Often inundated lowland rainforest on limestone ground, along streamlet with travertine cataracts, on bark. Coll.: *T. Pócs & S. Somadee 1220/B*. The species is distinguished from the related *Ch. intertexta* by its orbicular leaf lobe and the presence of flagelliform branches.
Known distribution: China: Hong Kong and Japan: Ryukyu Islands (Zhu & So 2001).

***Cololejeunea dankiaensis* Tixier, 1969**
Localities: Mt. Khao Ramrome, see No. 1, epiphyll. (For saving space, we do not repeat already given localities, just refer to the serial number of species, where it is described in details). Coll.: *T. Pócs, S. Chantanaorrapint & G.E. Lee 1209/AD*.
Known distribution: S Vietnam, Cambodia (Tixier 1969).

***Cololejeunea diaphana* A. Evans, 1905** (Fig. 11)
Localities: Nakhon Si Thammarat Prov.: Khao Luang Nat. Park, Karome Waterfalls on the S slopes, at 200-300 m alt. 08°22.37'N, 99°42.00'E. Hill rainforest on the E side of the falls, epiphyll. Coll.: *T. Pócs 1223/AB*.
Known distribution: Pantropical.

***Cololejeunea ensifera* Tixier, 1969** (Fig. 12)
Localities: Mt. Khao Ramrome, see No. 1, epiphyll. Coll.: *T. Pócs, S. Chantanaorrapint & G.E. Lee 1209/AF, 1209/JB*.
Known distribution: S-Vietnam, Cambodia (Tixier 1969).

***Cololejeunea inflectens* (Mitten) Benedix, 1953** (Fig. 13)
Localities: Mt. Khao Ramrome, see No. 1, epiphyll. Coll.: T. *Pócs, S. Chantanaorrapint & G.E. Lee 1209/AA*; Nakhon Si Thammarat Prov.: Summit of Mt. Khao Ramrome 8 km NW of Ron Phibun town, on a sharp ridge around Khao Ramrome Resort at 930-940 m alt. 08°14.18'N, 99°48.182'E. Montane rainforest, on twigs. Coll.: *T. Pócs & G.E. Lee 1213/Y*; Nakhon Si Thammarat Prov.: Mt. Khao Lek, abandoned iron mines near Huai Phan village, at 220 m alt. 08°46.56'N, 99°43.41"E. Remnants of see mist effected hill rainforest, epiphyll. Coll.: *T. Pócs, G.E. Lee & K. U-Taynapuh 1216/P*.
Known distribution: Palaeotropical species, from Madagascar and Seychelles to Fiji Islands (Pócs et al. 2011).

***Cololejeunea kulelensis* Tixier, 1985**
Localities: Nakhon Si Thammarat Prov.: Pliu (Plew) Waterfall area 9 km E of Thung Song town, at 185-212 m alt. 08°09.78'N, 99°45.59'E. Primary hill rainforest in a rocky stream valley dominated by *Quercus* and *Castanopsis* spp., epiphyll. Coll.: *T. Pócs & G.E. Lee 1211/AN*.
Known distribution: Sumatra, Cambodia, Peninular Malaysia and Fiji (von Konrat et al. 2010; Pócs et al. 2011).

***Cololejeunea latilobula* (Herzog) Tixier, 1985** (Fig. 14)
Localities: Nakhon Si Thammarat Prov.: Klong Jang Waterfalls on the W slope of KHAO MEN Mt. at 150 m alt. 08°16.24'N, 99°38.67'E. Hill rainforest around the falls, on granitic rocks. Coll.: *T. Pócs & S. Somadee 1218/A,1218/AC*.
Known distribution: Widespread Palaeotropical species distributed all over Africa, Asia and the Pacific.




***Cololejeunea madothecoides* (Stephani) Benedix, 1953**

Localities: Nakhon Si Thammarat Prov.: Krung Ching Waterfall area (annex of Khao Luang National Park) near Phi Tam village, at 160-240 m alt. 08°43.41'N, 99°40.09'E. Wet hill rainforest below the falls, on bark of *Homonoia riparia* (Euphorbiaceae) bush on the streambed rocks. Coll.: *T. Pócs, G. E. Lee & K. U-Taynapuh 1217/J*.

Known distribution: India, Bhutan, Vietnam, Japan, Sumatra, Java, Borneo, New Guinea (Asthana & Srivastava 2003; Pócs & Piippo 2011).

***Cololejeunea pacifica* Pócs, 2012** (Fig. 15).

Localities: Mt. Khao Lek, see No. 3, epiphyll, Coll.: *T. Pócs, G.E. Lee & K. U-Taynapuh 1216/K*.

Known distribution: Tonga: Vaifele (Eua Island); Tahiti: Fautaua Valley near Papeete and above the petroglyph rocks of Tipiare (Hürlimann 1987: 222); Fiji: Viti Levu and Kadavu Islands (Pócs 2012). It is new to the whole Indomalesia and Asia. *C. pacifica* and *C. cardiocarpa* form an interesting vicariant pair of related, allopatric species. *Cololejeunea cardiocarpa* is very widespread in the Neotropics and in Africa and occurs in Eastern Australia and New Caledonia as well never overlapping in its distribution with the Pacific and Asian *C. pacifica*.

***Cololejeunea paucimarginata* Tixier, 1985** (Fig. 16)

Localities: Tone Nga Chang waterfall area, see No.2, on streambed rocks, Coll.: *T. Pócs & G.E. Lee 1207/E*; Nakhon Si Thammarat Prov.: In the rocky stream valley below the Pliu Waterfalls 8 km E of Thung Song town, at 140-160 m alt. 08°09.50'N, 99°45.36'E. Secondary rainforest. Coll.: *T. Pócs & G.E. Lee 1212/D*.

Known distribution: Hitherto considered to be an endemic of Java (Tixier 1985).

***Cololejeunea raduliloba* Stephani, 1895** (Fig. 17)

Localities: Songkhla Prov.: Ban Huare village area 22 km WSW of Hat Yai town, at 50 m alt. 06°57.20'N, 100°16.12'E. Stream side in a rubber plantation replacing former lowland rainforest, on rocks. Coll.: *T. Pócs & G.E. Lee 1208/D*; Pliu Waterfalls, see No. 13, on streambed rocks. Coll.: *T. Pócs & G.E. Lee 1212/P*.

Known distribution: Plaeotropical species distributed from the Seychelles and Madagascar through Indonesia and China to Australia, New Caledonia, Fiji and Caroline Islands (von Konrat et al. 2010; Pócs et al. 2011).

***Cololejeunea spathulifolia* (Stephani) Tixier, 1985** (Fig. 18)

Localities: Pliu Waterfall area, see No. 7, epiphyll.

Known distribution: Réunion, Vietnam, New Caledonia and Hawaii (Tixier 1985).

***Cololejeunea stephanii* Schiffner ex Benedix, 1953** (Fig. 19)

Localities: Mt. Khao Ramrome, see No. 1, epiphyll. Coll.: *T. Pócs, S. Chantanaorrapint & G.E. Lee 1209/AE*.

Known distribution: Java, Sumatra, Malaysia, Sabah, Philippines: Mindanao (Tixier 1978); China: Hainan, New Guinea (Zhu 1995).

***Colura brevistyla* Herzog, 1921** (Fig. 20)

Localities: Mt. Khao Lek, see No.3. Coll.: *T. Pócs, G.E. Lee & K. U-Taynapuh 1216/M*.

Known distribution: Sri Lanka, Philippines, Mariana and Fiji Islands (Pócs et al. 2011).

***Colura leratii* (Stephani) Stephani, 1916** (Fig. 21)

Localities: Pliu Waterfalls, see No. 13, epiphyll. Coll.: *T. Pócs & G.E. Lee 1212/Q*.

Known distribution: Indomalesian-Pacific species widespread from India to New Caledonia and Fiji. (Pócs & Eggers 2007).

***Colura ornata* K.I. Goebel, 1891** (Figs 22-23)

Localities: Krung Ching Waterfall, see No. 11. Wet hill rainforest below the falls, epiphyllous. Coll.: *T. Pócs, K. U-Taynapuh 1217/AE, 1217/AH*. (Fig. 22). Noticeable are the peculiar shaped, more than 50 celled gemmae of this species, observed for the first time (see fig. 23), with their four adhesive cells.

Known distribution: Java, Peninsular Malaysia, Borneo, Philippines: Luzon, China (Jovet-Ast 1954; Piippo 1990).

***Colura pallida* Stephani, 1916** (Figs 24-25)

Localities: Khao Ramrome summit area, see No. 1, epiphyllous and 7, on bark. Coll.: T. Pócs, S. Chantanaorrapint & G.E. Lee & K. U-Taynapuh 1209/AY, 1213/M. The gemmae of this species were observed as round, consisting of approximately 40 cells (fig. 24).

Known distribution *of C. pallida:* It was considered to be an endemic of New Guinea (Jovet-Ast 1954).

***Lepidolejeunea graeffei* (Jack, Stephani) R.M. Schust, 1980**

Localities: Nam Tok Sikiet Nat. Park, see No. 2, on bark. Coll.: *T. Pócs & S. Somadee 1220/BB,*

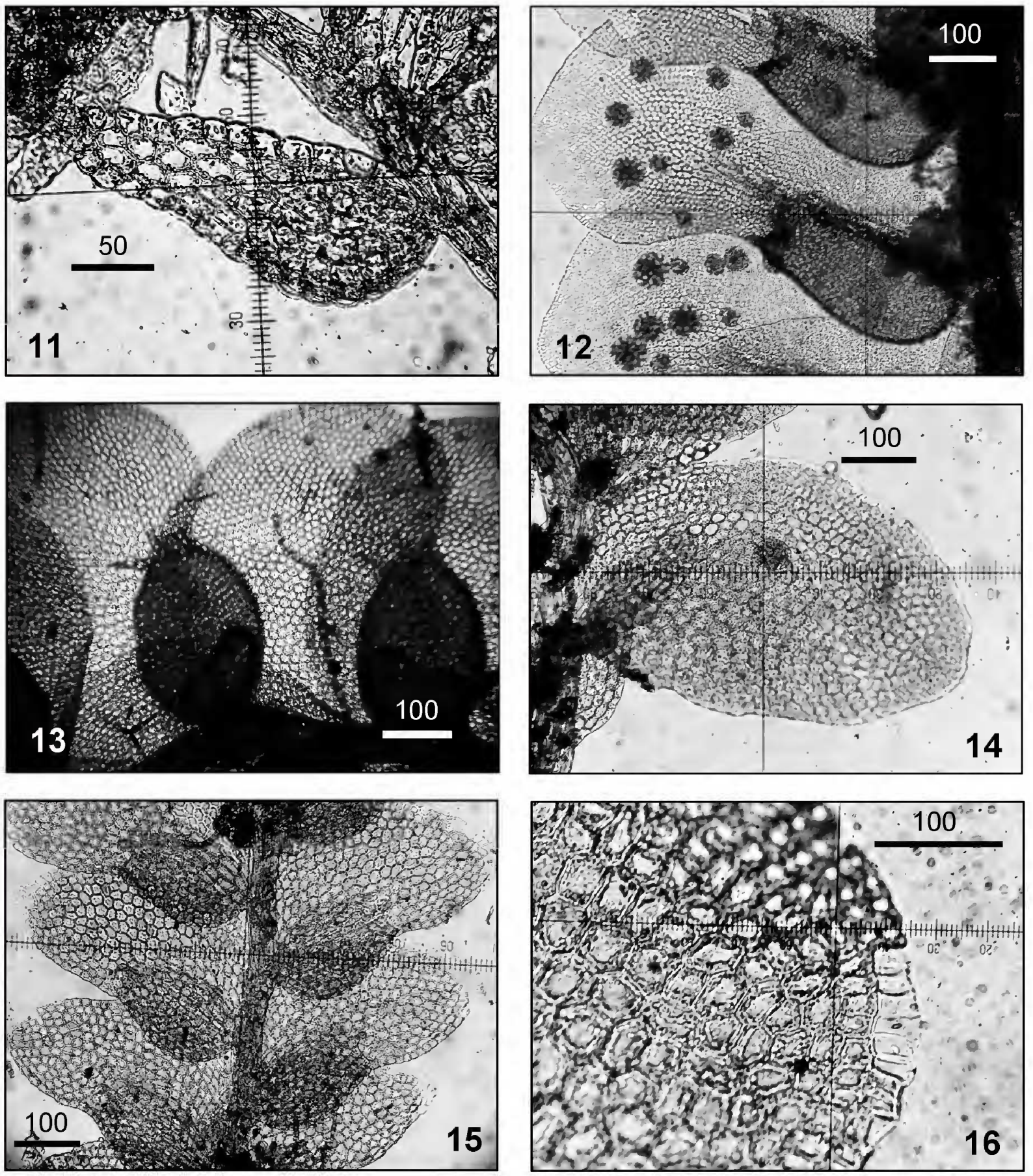



1220/O.

Known distribution: Indonesia, Philippines, New Guinea, Solomon Islands, New Caledonia, Vanuatu, Caroline, Fiji, Samoa (Piippo 1986; Thouvenot et al. 2011).

***Leptolejeunea subrotundifolia* Herzog, 1942** (Figs 26-28)

Localities: Krabi Prov.: Sa Morakot (Crystal Pool) Reserve, 5 km SE of Klong Thom Nuea, at 70 m alt. 07°55.92'N, 99°16.20'E. Open woodland on travertine banks of "Emerald Pool" formed by *Madhuca malaccensis* (C.B. Clarke) H.J. Lam (Sapotaceae)



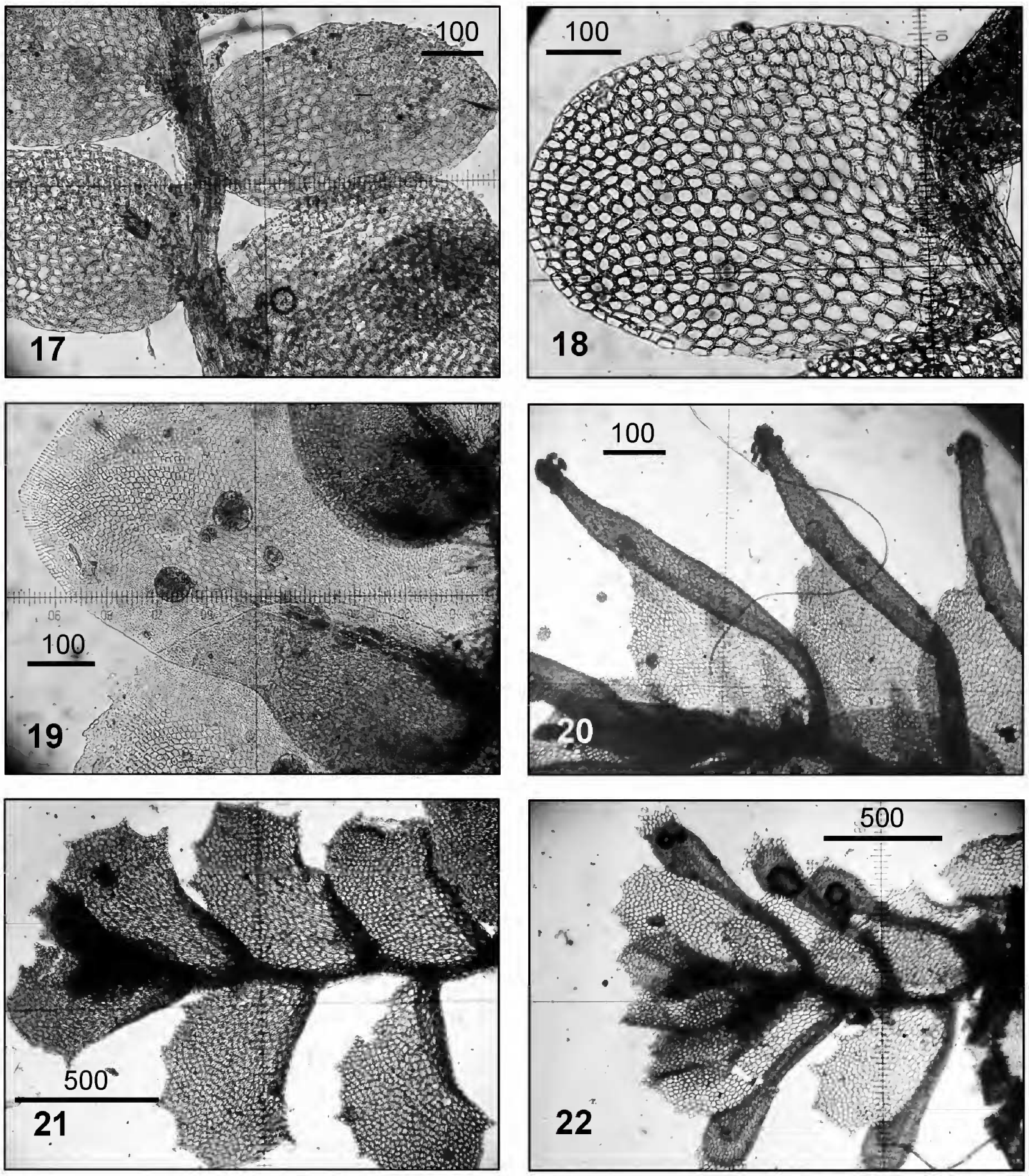
Figures 11-16. *Cololejeunea* species. 11 – *Cololejeunea diaphana* A. Evans, leaf,ventral view, no.1223/AB; 12 – *Cololejeunea ensifera* Tixier, leaf, ventral view, no. 1209/JB; 13 – *Cololejeunea inflectens* (Mitt.) Benedix, laf, ventral view, no. 1213/Y; 14 – *Cololejeunea latilobula* (Herz.) Tixier, leaf, ventral view, no. 1218/A; 15 – *Cololejeunea pacifica* Pócs, shoot, ventral view, no. 1216/K; 16 – *Cololejeunea paucimarginata* Tixier, lobe apex, no. 1207/E [scale bars in μm].

trees and masses of *Pteris* sp. in the undergrowth. On bark of *Rademachera pinnata* (Blanco). Coll.: *T. Pócs & S. Somadee 1228/C*. The gynoecium of this species was observed the first time (see fig. 27), as the type specimen of this dioicous plant has only androecia.

Known distribution: only the type locality in Kalimantan Barat (Herzog 1942), also from bark. Most of the other *Leptolejeunea* species are epiphyllous.

***Radula* cf. *kinabaluensis* Yamada, 1973**

Localities: Khao Ramrome, see No. 1, epiphyllous. Coll.: *T. Pócs, S. Chantanaorrapint & G.E. Lee 1209/U*.



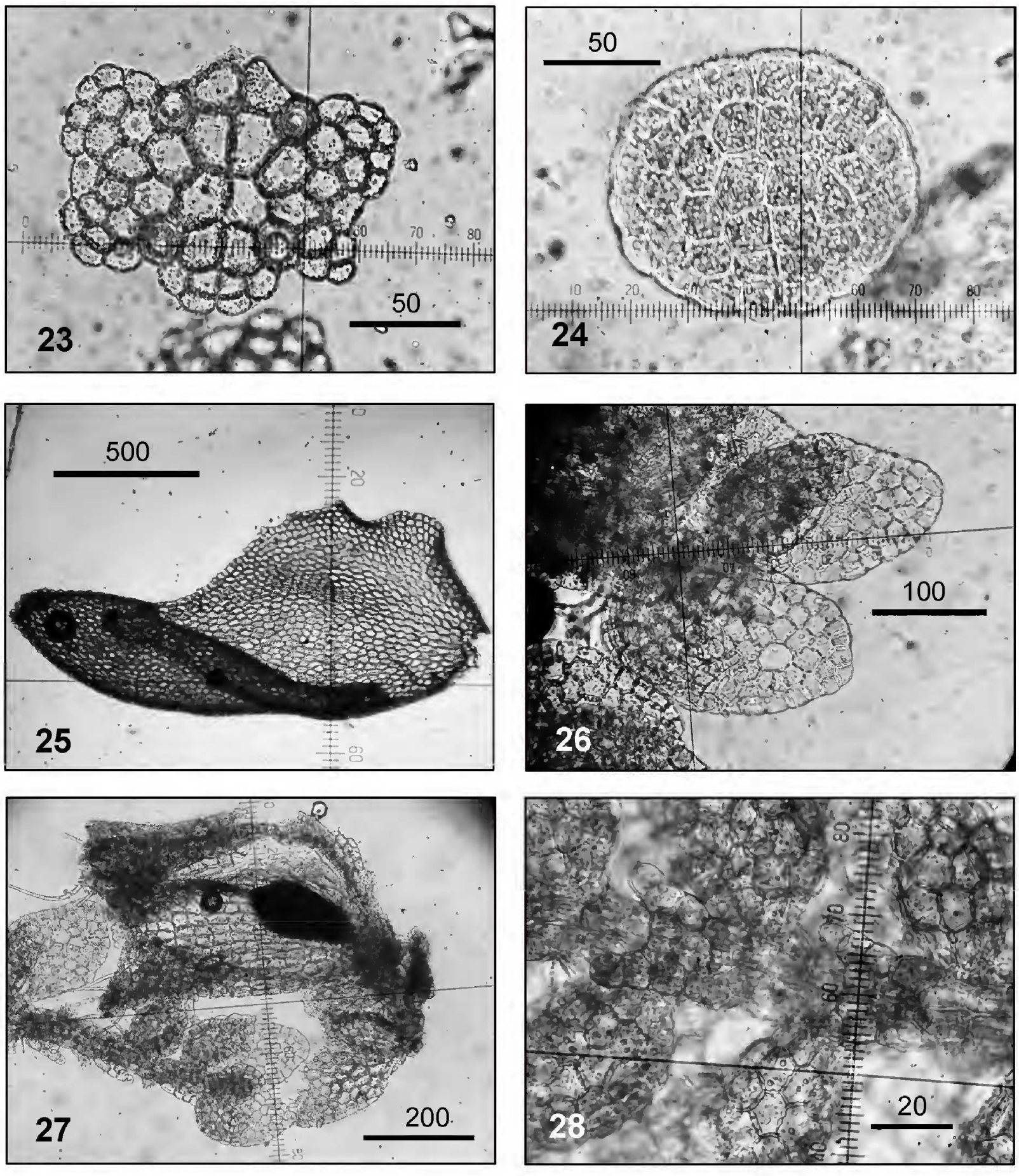
Figures 17-22. *Cololejeunea* and *Colura* species. 17 – *Cololejeunea raduliloba* Steph., shoot, ventral view, no. 1208/D; 18 – *Cololejeunea spathulifolia* (Steph.) Tixier, leaf, ventral view, no. 1211/AO; 19 – *Cololejeunea stephanii* Schiffn. ex Benedix, leaf, ventral view, no. 1209/AE.; 20 – *Colura brevistyla* Herz., shoot, ventral view, no. 1216/M; 21 – *Colura leratii* (Stzeph.) Steph., shoot, ventral view, no. 1212/Q; 22 – *Colura ornata* K.I. Goebel, shoot, ventral view, no. 1217/AH [scale bars in µm].

Known distribution: Hitherto considered to be endemic to Borneo: Mt. Kinabalu (Yamada 1979).

***Radula protensa* Lindenberg, 1848**

Localities: Krabi Prov.: Sa Morakot (Crystal Pool) Reserve, 5 km SE of Klong Thom Nuea, at 60-70 m alt. 07°55.45'N, 99°15.66'E. Swamp forest along streamlet with travertine banks, on bark. Coll.: *T. Pócs & S. Somadee 1227/E*.

Known distribution: Indomalesian species distributed from India to south China, Philippines and New Guinea (Yamada 1979).



Figures 23-28. *Colura* and *Leptolejeunea* species. 23 – Gemma of *Colura ornata* K.I. Goebel, no. 1217/AH; 24 – Gemma of *Colura pallida* Steph., no. 1209/AY; 25 – *Colura pallida* K.I. Goebel, leaf, ventral view, no. 1209/AY; 26–28 – *Leptolejeunea subrotundifolia* Herz. no. 1227/E; 26 – shoot, ventral view; 27 – Gynoecium; 28 – Underleaves [scale bars in μm].

Discussion

Although a full phytogeographical analysis of Thai bryoflora is at the present level of our knowledge cannot be done, some approach was made by Lai et al. (2008), counting the generic similarity to China is 75.6%, to Borneo 72.7% and to Japan 72.5%. Obviously this is a generalised picture and the northern half of the country shows more affinity to the Sino-Japanese flora while the southern half to the Malesian one. This fact is reflected even in the distributional data of the above new records, of which *Cheilolejeunea lindenbergii* (Gottsche) Mizutani, *Cololejeunea kulelensis* Tixier, *C. madothecoides* (Stephani) Benedix, *C. stephanii* Schiffner ex Benedix, *Colura brevistyla* Herzog, *C. leratii* (Stephani) Stephani, *C. ornata* K.I. Goebel, *C. pallida* Stephani, *Lepidolejeunea graeffei* (Jack, Stephani) R.M. Schust, and *Leptolejeunea subrotundifolia* Herzog have Malesian–Pacific affinities. Noticeable are the very disjunct occurrence of a few species of this kind, like *Cololejeunea pacifica* Pócs, *C. paucimarginata* Tixier and that of *Leptolejeunea subrotundifolia* Herzog. The number of Indochinese endemic species is considerable, *Cololejeunea dankiaensis* Tixier, *C. ensifera* Tixier and *Cololejeunea ramromensis* Pócs sp. nov. [described above] can be classified in this group. On the other hand, only *Cheilolejeunea ryukyuensis* Mizutani can be considered as a taxon of Sino-Japanese affinity and the rest of the species are more widespread. If we compare the above 23 new records to the known number of Thai liverworts (386), we can agree with the statement of Lai et al. (2008), that many of the liverwort taxa are still waiting for discovery in Thailand.

Acknowledgements

Thanks are due to Prince of Songkla University (Prof. Anchana Prathep, Chutamas Satasook and Prof. Kitichate Sridith (Hatyai, Thailand)) for their hospitality and help during the visit, to Dr. Kittichon U-Taynapuh from the Department of Biochemistry (Thung Song, Thailand) for bringing us to nice localities around Thung Song town and to Mrs. Surisa Somadee (Thailand Hoya Club, Khao Men Resort, Thailand) for her guidance in Nakhon Si Thammarat Province. The authors thank Dr. Matt von Konrat, Prof. Lars Söderström and Anders Hagborg (Department of Biology, Norwegian University of Science and Technology, Trondheim, Norway) providing them with the unpublished database of ELPT. The second author is grateful for the financial support of the Hungarian Academy of Sciences. The SEM pictures were made in the Botany Department of Hungarian Natural History Museum (BP) by a Hitachi S-2600 N type scanning electron microscope with the kind assistance of Dr. Krisztina Buczkó (Department of Botany, Hungarian Natural History Museum, Budapest, Hungary).

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